Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Expanding Flexible Use of the 3.7 to 4.2 GHz Band	)	GN Docket No. 18-122
	)	
Petition for Rulemaking to Amend and Modernize Parts 25 and 101 of the Commission's Rules to Authorize and Facilitate the Deployment of Licensed Point-to-Multipoint Fixed Wireless Broadband Service in the 3.7-4.2 GHz Band	)	RM-11791
	)	
Fixed Wireless Communications Coalition, Inc., Request for Modified Coordination Procedures in Band Shared Between the Fixed Service and the Fixed Satellite Service	)	RM-11778

COMMENTS OF GOOGLE LLC

Megan Anne Stull
Counsel

Andrew W. Clegg, PhD
Spectrum Engineering Lead

Google LLC
25 Massachusetts Avenue NW
9th Floor
Washington, DC 20001

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COMMENTS OF GOOGLE LLC

Google commends the Commission for seeking comment on sharing Fixed-Satellite Service (FSS) spectrum with point-to-multipoint (P2MP) systems, along with other ideas for expanding the use of C-band frequencies.[1] In addition to reallocating as much C-band spectrum as possible for flexible use through an open and nondiscriminatory reallocation process, the Commission should make comparatively minor modifications to the Part 101 rules to allow automatically-coordinated P2MP systems to operate around remaining incumbent FSS earth stations. In doing so, the Commission would immediately enable gigabit-class fixed wireless broadband for more

[1] Public Notice, *Wireless Telecomms. Bureau, Int'l Bureau, Office of Engineering and Tech., and Office of Econs. and Analytics Seek Focused Additional Comment In 3.7-4.2 GHz Band Proceeding*, GN Docket No. 18-122, RM-11791, RM-11778, DA 19-678 (rel. July 19, 2019) (*Public Notice*).

than 80 million Americans, without harmful interference to FSS operations. Shared use of the C-band frequencies between FSS incumbents and P2MP broadband service providers would help to close the rural digital divide, augment Internet access competition, and promote available and affordable fixed 5G service offerings.

I. INTRODUCTION AND SUMMARY

Shared use of C-band frequencies populated by FSS would help to solidify United States leadership in the development of 5G applications including fixed wireless access, and the deployment of spectrum sharing technologies. By authorizing such sharing now, the Commission can maximize the use of the entire C-band in the near term while maintaining full flexibility for additional clearing in the long run. In particular, a requirement for P2MP systems to be frequency-agile would allow the systems to adjust to future expansion of an exclusive, flexible use allocation in current C-band spectrum, if such expansion came to be.

To enable deployment of P2MP fixed broadband services in the C-band, the Commission should implement rules consistent with a few straightforward principles:

- The Part 96 technical criteria that protect FSS earth stations from co- and adjacent-channel 3.5 GHz Citizens Broadband Radio Service (CBRS) devices are equally suitable for newly authorized P2MP operations in the C-band.

- The Commission should discontinue the inefficient and over-protective policies of the FSS industry that unnecessarily impede sharing of C-band spectrum, in particular the unjustified full-band, full-arc registrations that typically vastly overstate the amount of spectrum being used and impede coordination in directions to which the earth station is never actually pointed.

- The *Reed Study*, on which the *Public Notice* requested comment, convincingly shows that the current exclusion zones for fixed service transmitters around

> C-band FSS earth stations are too large.[2] Indeed, the results of the *Reed Study* are borne out by *actual* co-channel operations between broadband systems and FSS earth stations in the extended C-band. The Commission should pare back these earth station protection zones for P2MP operations in the C-band.

The result will be a modernization and rationalization of Part 101 that benefits the public interest. As Commissioner O'Rielly recently observed, "We no longer have the luxury of over-protecting incumbents via technical rules, enormous guard bands, or super-sized protection zones. Every megahertz must be used as efficiently as possible."[3]

As the Commission knows, expanding broadband access in rural America will generate significant economic benefits. For instance, a recent study of 35 OECD countries, including the United States, over a 15-year period confirmed the link between broadband adoption and gross domestic product (GDP) growth, revealing a GDP increase of 4.34% for the countries studied when broadband penetration increased from 3.8 connections per 100 people to 31.3 connections per 100 people.[4] The Commission should act quickly to bring these benefits to rural communities and to our nation as a whole by opening C-band spectrum to frequency-coordinated P2MP operations.[5]

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[2] *See* Letter from Wireless Internet Serv. Providers Ass'n, Google LLC, and Microsoft Corp., to Marlene H. Dortch, Secretary, FCC, in GN Docket No. 18-122, at Attachment (filed July 15, 2019) (*Reed Study*).

[3] Remarks of FCC Comm'r Michael O'Rielly Before the Wi-Fi Alliance Annual Member Meeting (June 4, 2019), at 4, *available at* https://docs.fcc.gov/public/attachments/DOC-357794A1.pdf.

[4] Pantelis Koutroumpis, *The Economic Impact of Broadband: Evidence from OECD Countries*, Apr. 2018, at 8, *available at* https://www.ofcom.org.uk/__data/assets/pdf_file/0025/113299/economic-broadband-oecd-countries.pdf.

[5] *See In the Matter of Inquiry Concerning Deployment of Advanced Telecomms. Capability to All Americans in a Reasonable and Timely Fashion*, 2019 Broadband Deployment Report, GN Docket No. 18-238, ¶¶ 2, 33 (2019) (stating that 21.3 million

II. THE COMMISSION SHOULD ALLOW SHARING BY FIXED P2MP SYSTEMS IN THE REMAINING C-BAND SATELLITE SPECTRUM

As the Commission observed in the *NPRM*, C-band spectrum has desirable propagation characteristics, offers near-line-of-sight capability at low power for last-mile services, and has sufficient capacity to accommodate last-mile, fixed wireless broadband connectivity at up to gigabit speeds.[6] Solely for illustration (and without endorsing the C-band Alliance's private sale proposal), if the Commission were to accept satellite interests' position that 200 MHz can be cleared for flexible use at this time and FSS therefore remained within 300 MHz of upper C-band spectrum, then fixed P2MP providers sharing those same frequencies could bring gigabit-class broadband service to more than 80 million Americans, many in rural, small town, tribal, or other underserved areas.[7] This would complement clearing of the lower C-band to promote the growth of 5G mobile networks, which at least initially will be concentrated in densely populated areas. At the same time, FSS earth station incumbents would operate without disruption from P2MP systems.

Technical studies filed with the Commission—as well as actual deployed systems, as discussed below—demonstrate that P2MP and FSS services can coexist in the C-band. In March 2018, Google and the Broadband Access Coalition filed initial

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Americans still lack a broadband connection of 25 Mbps/3 Mbps, and showing that more than 26% of Americans in rural areas, and more than 32% of Americans on tribal lands, lack a fixed terrestrial broadband connection of 25 Mbps/3 Mbps).

[6] *In the Matter of Expanding Flexible Use of the 3.7-4.2 GHz Band*, Order and Notice of Proposed Rulemaking, 33 FCC Rcd. 6915, ¶ 116 (2018) (*NPRM*).

[7] *See Reed Study* at 3, 42.

technical studies indicating that P2MP systems can offer fixed wireless broadband access services in the C-band to large areas of the country on a *co-channel* sharing basis, without harmful interference to FSS earth stations.[8] The studies suggest that a combination of geographic separation and FSS-aware network planning can ensure that P2MP fixed wireless signals reaching FSS sites remain below harmful interference thresholds, even without frequency separation.[9]

In July 2019, Google, WISPA, and Microsoft filed a follow-up study conducted by Professor Jeff Reed of Virginia Tech that independently verifies the technical results of the March 2018 study, and also incorporates the latest FSS registrations filed as a result of the Commission's efforts to update and improve the accuracy of the C-band registration database.[10] The *Reed Study* relies on conservative estimates and standards-based assumptions to show that earth stations can be coordinated and protected within a geographic exclusion zone of 10 km or less.[11] Using the latest earth station registration data, the *Reed Study* shows that more than 80 million Americans and 78% of the geographic area of the country—particularly rural areas where C-band earth stations are less prevalent and more widely dispersed—would benefit from

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[8] *See* Letter from Stephen E. Coran, Counsel, Wireless Internet Serv. Providers Ass'n, to Marlene H. Dortch, Sec'y, FCC, in GN Docket No. 17-183, RM-11791 (filed Mar. 29, 2018) (*BAC/Google Ex Parte*).
[9] *See id.*
[10] *See Temporary Freeze on Applications for New or Modified Fixed Satellite Service Earth Stations and Fixed Microwave Stations in the 3.7-4.2 GHz Band*, Public Notice, 33 FCC Rcd. 3841 (2018).
[11] *See Reed Study* at 32, 40 (analyzing a conservative line-of-sight propagation model, and explaining that several real-world conditions could make the exclusion zones even smaller).

making shared C-band spectrum available for P2MP services.[12] Repacking earth stations from the lower portion of the C-band into the upper portion of the C-band, in order to clear spectrum for flexible use licenses, would not lessen the benefits identified by the *Reed Study*: In light of the common practice of overbroad full-band, full-arc registrations and the repacking of earth stations into a smaller band, the study assumes that P2MP systems will be co-channel with all registered earth stations.[13]

Through coordination and existing spectrum database technologies, new P2MP operations in the C-band will be able to accommodate future changes in frequencies, pointing angles, and satellite signals received by earth stations, as reflected in the Commission's IBFS database.[14] Incumbent FSS space station operators will continue to be able to transmit the same signals to earth stations and to provide the same services to customers.

Furthermore, future clearing of additional C-band spectrum band would not be impeded. P2MP systems will be frequency agile and able to retune to any part of the band as necessary. Because co-channel sharing with FSS has been assumed from the outset, retuning will not create any additional coordination problems. The Commission could further ensure its freedom to clear more C-band spectrum in the future, if warranted, by requiring in Part 101 that P2MP devices be capable of operating across

[12] *See id.* at 39, 42.
[13] *See id.* at 4, 10.
[14] *See* Reply Comments of Google LLC in GN Docket No. 18-122, RM-11791, RM-11778, at 5 (filed Dec. 11, 2018) (noting that P2MP equipment could be operable across the C-band so that fixed operators could accommodate changes to the locations or frequencies in earth station registrations).

the full 500 MHz of the C-band (or whatever portion of the C-band remains usable by FSS after this proceeding is completed).[15] If repacking FSS operations reduced the amount of spectrum available for coordinated sharing, the reduction would occur disproportionately in urban and suburban areas, where the vast majority of earth stations are located and there is less geographic dispersal.[16] Substantial amounts of vacant spectrum would remain available in rural and underserved areas for P2MP broadband services capable of offering high-capacity and affordable services to users.[17] Particularly if earth station registrations are limited to spectrum and pointing angles the dishes actually use, frequency agile fixed broadband systems using a geolocation database would be able to accommodate large changes in spectrum availability.

Making the C-band available for fixed P2MP use can be achieved easily and quickly. Spectrum sharing in the C-band can occur without the need to draw on auction revenue or a Congressional appropriation. The C-band already supports commercial uses, and does not require sharing with or transfers of frequencies from Federal government users. Thus, the Commission would not need to implement sophisticated hierarchical sharing methods or exclusion zones. The band is already allocated on a co-primary basis to the fixed service, under which P2MP would operate. As explained below, existing frequency coordination criteria and procedures can be leveraged, using

[15] *See* Comments of Google LLC in GN Docket No. 18-122, RM-11791, RM-11778, at 4 (filed Oct. 29, 2018) (suggesting rule changes to Rule 101.103).
[16] *See* Reply Comments of the Pub. Interest Spectrum Coal. in GN Docket No. 18-122 at 23 (filed Dec. 11, 2018).
[17] *Id.* at 23, 25.

site data available in the Commission's ULS and IBFS databases. Equipment development can rely on technologies already being used in the adjacent CBRS band, and therefore can occur rapidly. Finally, as also discussed below, existing Part 101 frequency coordination processes can be used for P2MP until more automated coordination procedures are developed for the C-band.

Whereas mobile deployments are inherently moveable and omnidirectional and therefore relatively difficult to coordinate to ensure non-interference,[18] P2MP deployments are at fixed geographic locations and operate on a directional, sectorized basis. As Frontier and Windstream have observed, P2MP deployments are "much more controlled and contained compared to mobile uses," and automated frequency coordination would be "able to protect incumbent users and mediate any conflict."[19] Coordination therefore can ensure both geographic and directional isolation from earth station operations. Because P2MP is directional, successful coordination of sectors is possible when earth stations are in the same geographic area but outside the beam of the base station and the clients' return path.

The Commission can rely on its longstanding procedures for wireless broadband service in the 3650–3700 MHz band to allow fixed links to share the band with FSS C-band earth stations. For more than a decade, procedures in Rule 90.1321(b) for wireless broadband service have allowed fixed P2MP service links to share the

[18] *NPRM,* ¶ 50.
[19] Reply Comments of Frontier Commc'ns. Corp. and Windstream Servs., LLC in ET Docket No. 18-295, GN Docket No. 17-183, at 5 (filed Mar. 18, 2019) (*Frontier and Windstream Reply Comments*).

3650–3700 MHz band with FSS earth stations.[20] Furthermore, Part 96 rules require CBRS in this frequency range to protect FSS earth stations in the band, consistent with the existing protection criteria in Part 90, Subpart Z of the Commission's Rules. After the Part 90 wireless broadband licensees' grandfathered period expires and they transition to Priority Access License or General Authorized Access use, protection criteria in Rule 96.17 will apply.[21]

Extending this framework to FSS spectrum in the C-band would unlock unique and immediate benefits. As noted by Frontier and Windstream, the C-band is "prime spectrum for rural fixed wireless broadband deployment" because it "enables high-bandwidth applications while still allowing for non-line-of-sight deployments over considerable distance."[22] And, as Starry has observed, C-band spectrum combined with other bands would offer "a robust set of spectrum tools to deploy a highly-competitive and agile fixed network that can scale economically across geographies and household densities, bringing new access and competition to consumers across the country."[23]

The greatest opportunity for high-capacity, affordable broadband P2MP services would be in areas such as rural and tribal areas, where earth stations are less prevalent and widely dispersed. As Chairman Pai has observed, high-speed broadband services like those offered by P2MP providers enable Americans in rural areas to "fully

[20] 47 C.F.R. § 90.1321(b).
[21] *Id.* § 96.21(c).
[22] *Frontier and Windstream Reply Comments* at 4.
[23] Comments of Starry, Inc. in GN Docket No. 18-122 at 5 (filed Oct. 29, 2018).

participate in the digital economy [through] entrepreneurship, telemedicine, precision agriculture, online education, and more."[24]

Newly deployed P2MP systems would have the potential to offer vastly higher data speeds than satellite with lower latency and at lower costs.[25] Fiber-based solutions would be much more expensive due to the higher costs of network construction, and accordingly would require "substantial public subsidies in areas where population density on a per-road-mile basis is low."[26] Fixed P2MP broadband services can offer high-throughput services at capital costs that are only about one-seventh the cost of fiber deployment.[27] Fixed P2MP systems also can begin offering service much more rapidly than fiber-based systems. Deployments do not require pole attachments or "make-ready," environmental review is more streamlined, and construction is much faster. As the Broadband Access Coalition has explained, "[a]n access point can be mounted on an existing structure and placed into service almost immediately, in this case pending only frequency coordination."[28] Finally, fixed P2MP systems are more

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[24] FCC, *Over 106,000 Rural Homes And Businesses to Get Better, Faster Broadband*, Apr. 29, 2019, at 1, *available at* https://docs.fcc.gov/public/attachments/DOC-357211A1.pdf.

[25] *See* The Carmel Group, *Ready for Takeoff: Broadband Wireless Access Providers Prepare to Soar with Fixed Wireless* (2017), at 12, Figure 6, *available at* https://carmelgroup.com/wp-content/uploads/2017/12/TCG_2017_BWA_Full_Report.pdf (*Carmel Report*) (noting that the maximum available speed for satellite broadband in 2017 was 12-35 Mbps, while the maximum speed for P2MP offerings was 100 Mbps. P2MP connections, however, have the potential to provide more than 1 Gbps speeds to end users).

[26] Comments of the Broadband Access Coal. in GN Docket No. 18-122 at 12 (filed Oct. 29, 2018) (*BAC Comments*) (citing *Carmel Report* at Fig. 6).

[27] *Id.*

[28] *Id.* at 12-13.

cost-effective per gigabyte than mobile systems. Fixed P2MP uses highly-directional client antennas that have considerable gain, are mounted higher above ground than mobile devices operate (i.e., near rooftop height), and "can separate out signals from multiple base stations whose coverage may overlap on the same frequency."[29]

III. RESPONSES TO THE COMMISSION'S TECHNICAL QUESTIONS

Through minor changes to the Commission's rules, the recommendations in the *Reed Study* will enable C-band P2MP systems to achieve their promise and bring fixed wireless broadband access services to 80 million Americans or more on a shared basis in the non-cleared portion of the band, while avoiding harmful interference to incumbent FSS earth station operations. Below we discuss technical details of this promising approach and address the specific questions posed in the *Public Notice* concerning the *Reed Study*.

What are the appropriate interference thresholds and protection criteria, how should they be modeled, and under what deployment assumptions? How should protection criteria be calculated and implemented to achieve both in-band and adjacent band Fixed Satellite Service protections through coordination or other protection mechanisms?

CBRS operations are co-channel with FSS earth stations that operate in the "extended C-band" (i.e., earth stations that receive signals below 3700 MHz), and adjacent in frequency to FSS earth stations that operate in the "core" C-band above 3700 MHz. The Commission accordingly adopted Part 96 rules to protect extended C-band and regular C-band systems from co- and adjacent-channel interference caused

[29] *Id.* at 12.

by CBRS. The same rules should apply to systems operating under virtually identical co- or adjacent-channel circumstances above 3700 MHz. For instance, emissions within the passband of an FSS receiver (whether co-channel fundamental emissions from a co-channel transmitter, or out-of-band emissions from a non-co-channel transmitter that fall within the FSS receiver's passband) should meet an aggregate interference objective of -129 dBm/MHz after assuming 0.5 dB of filter loss at the FSS receiver.[30] And regardless of the relative frequencies of the transmitter and the FSS receiver, aggregate blocking interference should not exceed -60 dBm at the FSS receiver, after application of a default receiver filter profile.[31]

These interference criteria were enacted to protect co-channel and adjacent-band C-band earth stations against harmful interference from CBRS stations of all types, including P2MP systems operating between 3550 and 3700 MHz. They are equally suitable for P2MP/FSS sharing in the C-band. There is no difference between technologies operating in these frequencies from a received power perspective, and therefore no material difference from an engineering perspective. Thus, cross-referencing Part 96 technical rules in Part 101 would be an administratively convenient and logically appropriate way of ensuring that any future updates to the CBRS requirements are applied to P2MP/FSS sharing as well.

Should these criteria differ for telemetry, tracking, and command (TT&C) earth stations?

[30] 47 C.F.R. § 96.17(a)(2).
[31] *Id*. § 96.17(a)(3).

Part 96 protection criteria are identical for C-band TT&C as for other operations, and adopting different protection criteria for TT&C would be inconsistent with the approach taken in Part 96. There is another similarity between TT&C and general FSS operations, too: Much as FSS operators frequently register full-band, full-arc operations even when they are using only a fraction of the spectrum and pointing range, earth stations that are used only for TT&C operations often register across the band despite only using narrow bandwidths. TT&C operators should be required to file with the Commission their actual and specific frequency use for TT&C as well as for receiving payload signals, rather than claiming protection for most or all of the available C-band if only a narrow swath of spectrum is being used.

Given the needs of next-generation wireless networks and the need to ensure continuity of service for current users of FSS earth stations, what are appropriate technical parameters for terrestrial base stations and end user devices in the band, including transmit power limits and out-of-band emission limits?

The technical parameters for P2MP systems should be consistent with those recommended by WISPA and used as inputs to the *Reed Study*. Specifically, 100 W EIRP per 20 MHz bandwidth for base stations should be sufficient. This base station power level is consistent with the CBRS rules, which allow 47 dBm (50 W) EIRP per 10 MHz (or 100 W per 20 MHz) for Category B Citizens Broadband Radio Service Devices (CBSDs).[32] A slightly lower power can be used for Customer Premise Equipment (CPE). For example, 50 W per 20 MHz would be suitable. The CBRS rules allow CPE to operate at the same power level as Category B CBSDs when they initially connect to

[32] *Id*. § 96.41(b).

obtain SAS registration, and to continue operating at Category B power levels after being placed under the control of a SAS.[33]

Out-of-band limits should be consistent with those for the CBRS: -13 dBm/MHz conducted power out to 10 MHz beyond the channel edge, and a conducted limit of -25 dBm/MHz beyond that range.[34] For emissions outside of the P2MP band (for example, in the range 4250–4350 MHz that is used by aeronautical radio altimeters[35]), the conducted limit should be -40 dBm/MHz.[36]

We seek comment on suggestions by . . . the Reed Study on ways to increase efficient shared use of the C-band through validation of earth station filters, protection zones around stations, analysis of the relevant parameters of earth stations for protection (e.g., elevation angles, range of pointing angles, and frequencies that are used), and other technical matters. For example, which filters are actually realizable and available to achieve the sharing goals of the various proposals? Is it possible to achieve the short-term sharing goals of the proposals given the need to retrofit multiple types of Fixed Satellite Service earth station front-end elements (e.g., Low Noise Block downconverter/filter) and the susceptibility of Fixed Satellite Service receivers to Passive Intermodulation?

Filters. Because the *Reed Study* assumed co-channel operation between P2MP and FSS earth stations, use of filters would not be necessary to achieve the sharing goals discussed in the study.

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[33] *See* FCC, *Citizens Broadband Radio Service Devices Handshake Procedures*, April 19, 2019, *available at* https://apps.fcc.gov/kdb/GetAttachment.html?id=Z8%2Fky2FNqkvNLYv2BUrK3Q%3D%3D&desc=940660%20D02%20CPE-CBSD%20Handshake%20Procedures%20v01&tracking_number=229297.

[34] *See* 47 C.F.R. § 96.41(e).

[35] *C.f.* Rockwell Collins, *Installation Manual: ALT-1000 Radio Altimeter System*, July 18, 2012, § 4.3.1.13, *available at* https://seb.noaa.gov/pub/seb/TwinOtterSupportFiles/Documentation/Aircraft%20systems/ALT-1000%20Install%20Manual%20(5230806452).pdf.

[36] *See* 47 C.F.R. § 96.41(e)(2).

Protection Zones. Current protection zones extend enormous distances. For example, the 150 km exclusion zones under Part 90Z cover over 70,000 square km *for a single earth station*, a bigger area than ten of the U.S. states. These zones were instituted decades ago, before spectrum demand had risen to its current levels that make efficient spectrum sharing critical. At that time, individual services could enjoy unfettered access to broad swaths of spectrum, and extremely simple and conservative propagation models like free space loss were used because calculation by hand or by slide rule was required, and terrain and clutter data were unavailable.

Today's environment is entirely different and calls for a renewed evaluation of protection zones. The *Reed Study* used modern but conservative assumptions in order to calculate more precise earth station protection zone boundaries. It found that on average, a zone radius of only 10 km or so is necessary to protect earth stations from properly engineered P2MP systems. P2MP systems must undergo network planning before deployment, at which time the locations of earth stations in the area can be taken into account. P2MP systems can avoid pointing antennas toward earth stations using modern 5G beamforming capabilities that allow energy to be placed where it is needed and avoid those directions where it is unnecessary.

Actual FSS operations confirm the *Reed Study*'s conclusions. Currently, extended C-band earth stations share the 3650–3700 MHz band with fixed broadband systems (including P2MP) operating under Part 90 rules. Although Part 90 devices are prohibited from operating within the 150 km exclusion zones around earth stations, Part

90 allows broadband operators to coordinate with FSS operators to allow broadband deployments within exclusion zones.[37] In reality, many Part 90 operators already operate inside such zones—some virtually next door to C-band earth stations—with no apparent interference. Figure 1, covering the Los Angeles area, shows the juxtaposition of Part 90 stations (red dots) to co-channel extended C-band earth stations (white dots), with the large red circles indicating the 150 km radius exclusion zones. Many Part 90 devices (red dots) are well inside the large exclusion zones (large red circles).

Figure 1

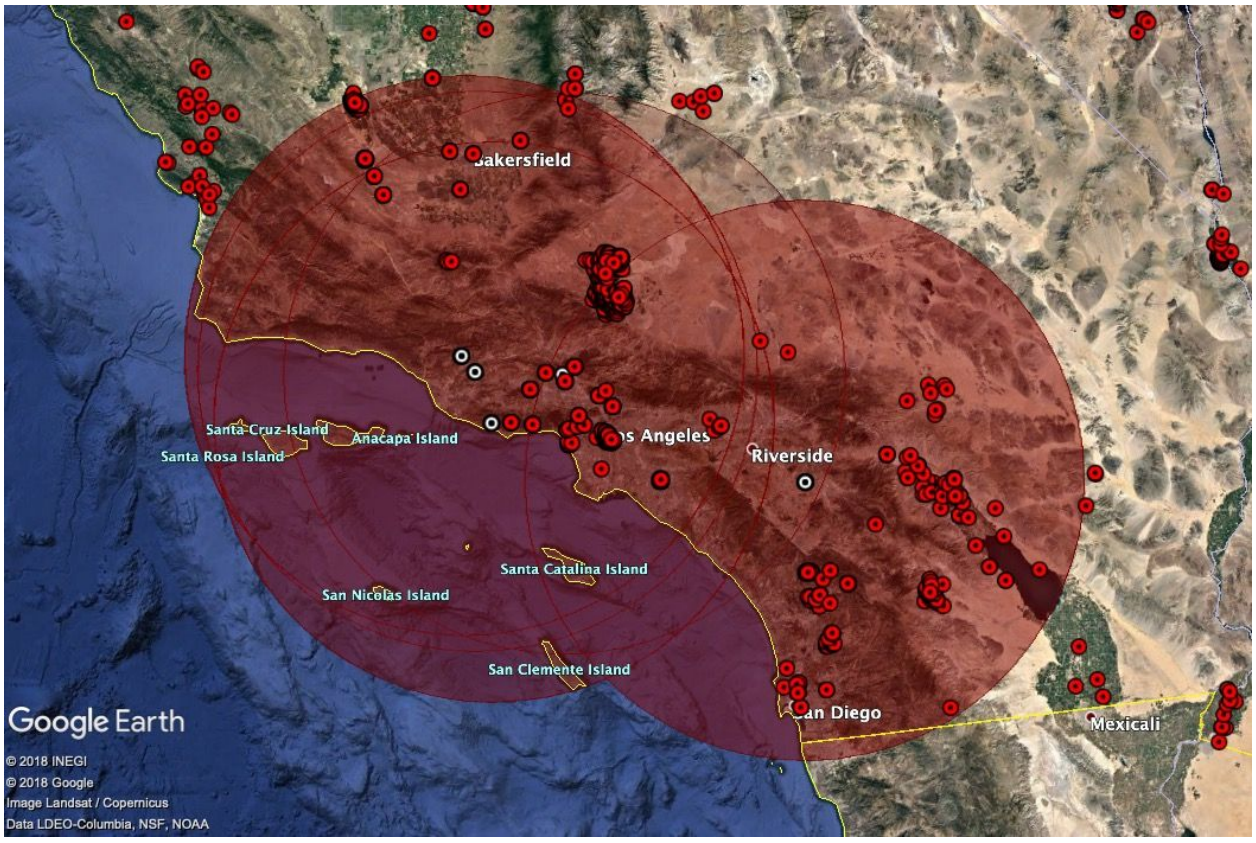

Figure 1: Numerous co-channel Part 90 Wireless Broadband Systems operate well inside the 150-km super-sized FSS "exclusion" zones surrounding C-band earth stations.

[37] 47 C.F.R. § 90.1331(a).

Figure 2 depicts a specific example of the juxtaposition of fixed broadband systems with FSS earth stations. In this case, a wireless broadband system[38] is beaming approximately 7 W EIRP *directly at* an FSS earth station[39] that is only 10.3 km away—very close to the typical 10-km exclusion zone calculated in the *Reed Study* that assumed only sidelobe radiation from a P2MP system toward an earth station—and that is registered to operate co-channel with the broadband system. Notably, one of the C-band dishes at the KA91 site is pointed almost directly back toward the broadband station. This example proves the fundamental assertion of the *Reed Study*: When taking all factors into account, fixed broadband systems can (and already do) co-exist with co-channel earth stations over distances that are a small fraction of the 150-km radius.

[38] *See* License of Nextweb, Inc. (Call Sign WQND843), at Location 158. Site CAS, transmitting on 3650-3700 MHz, https://wireless2.fcc.gov/UlsApp/UlsSearch/licenseLocDetail.jsp?keyLoc=15966671&licKey=3256022&rsc=NN (last visited Aug. 7, 2019) (listing EIRP of 38.4 dBm).
[39] *See* Fixed Earth Station Authorization of AT&T Corp. (Call Sign KA91), File No. SES-RWL-20061002-01793, receiving on 3625–4200 MHz, https://licensing.fcc.gov/myibfs/displayLicense.do?filingKey=-117087.

Figure 2

Figure 2: The main beam of this broadband operator's site is pointed directly at a co-channel FSS earth station only 10.3 km away. The *Reed Study* predicted a "right-sized" protection zone of 10 km, which is borne out by this example.

Coordination Procedures. When FSS/P2MP shared use of C-band is approved, the Commission also should adopt a reasonably-sized radius around FSS earth stations within which any P2MP system or node must coordinate with the earth stations' operations. Such coordination could best be accomplished using modern terrain- and clutter-aware propagation models that take into account site-specific conditions. Specifically, the coordination should:

i. be automated based upon adopted protection criteria for FSS earth stations;

ii. be conducted at the time of P2MP network planning; and

iii. result in automated and instantaneous determination regarding compatibility with earth stations within the coordination radius. A 30-day allowance for postal mail, as required in the current but dated Part 101 rules,[40] would not be required in the coordination process.

The Broadband Access Coalition previously filed with the Commission a short list of changes to Part 101 rules that would enable shared use of the C-band by P2MP systems using a simplified automated admission process.[41] Google supports those proposals.

Is it possible to achieve the short-term sharing goals of the proposals given the need to retrofit multiple types of Fixed Satellite Service earth station front-end elements (e.g., Low Noise Block downconverter/filter) and the susceptibility of Fixed Satellite Service receivers to Passive Intermodulation?

With co-channel sharing and compliance with strict co-channel interference criteria for shared P2MP use, issues related to interference caused by strong signals, such as intermodulation, will not occur. P2MP signals as received at an earth station site will be very weak and unlikely to generate any harmful interference, without any need to retrofit FSS receivers.

We seek comment on appropriate parameters to manage co-existence of terrestrial stations with earth stations during any band transition where differing amounts of spectrum might be cleared during different time periods for nearby geographic areas.

The *Reed Study* assumes co-channel operations between P2MP systems and FSS. While repacking FSS operations to a smaller section of the C-band generates

[40] 47 C.F.R. § 101.103(d)(2)(v).
[41] *See BAC Comments* at 22-32.

more geographically-concentrated earth station use in repacked frequencies, the *Reed Study* already takes into account co-channel sharing with *all* 18,000+ earth stations. Only the location of the earth stations is pertinent, not the frequencies used. With co-channel sharing, coexistence with the FSS system has been assured based on known location and beam characteristics. FSS systems could modify or expand their frequency use instantly, without adversely affecting either FSS or P2MP operations.

Of course, a reasonable FSS registration policy that eliminates full-band, full-arc overstatements would leave C-band frequencies available for use by P2MP without the more restrictive situation of operating co-channel. If the *Reed Study* examined non-co-channel use rather than conservatively assuming that FSS and P2MP systems are always co-channel, the result would have been even greater opportunity for P2MP links than those described above. By banning "full-band, full-arc" registrations for the vast majority of C-band earth stations not requiring them, P2MP providers can achieve greater levels of broadband penetration.

IV. ADDITIONAL TECHNICAL CONSIDERATIONS

The Commission also should consider the following information when evaluating shared P2MP/FSS use in the C-band:

Automated coordination can be accomplished with highly simplified versions of Spectrum Access Systems (SASs).

In the CBRS band, the SASs are necessarily complex because of two key considerations: the dynamic nature of incumbent military activity, and the classified

nature of that activity. A SAS cannot know in advance when and where such activity will occur, and therefore must be "at-the-ready" to reconfigure CBSDs within a five-minute period to avoid causing interference to military operations.

In the C-band, however, automated coordination is much simpler. With the exception of occasional portable operations, FSS operations are generally static, with the earth stations operating at locations that are known in advance. With the exception of occasional portable operations, new earth stations do not suddenly appear. Furthermore, because P2MP systems undergo network planning long in advance of actual deployment, potential operators can know with reasonable certainty months in advance whether a proposed deployment is feasible.

Automated coordination will protect portable C-band operation.

Some activities of C-band FSS operators, such as coverage of golf tournaments, football games, and other large events, are accomplished using portable terminals. The date and location of such events are known well in advance, allowing automated coordination systems to plan around them. Network planning tools can warn potential P2MP operators that their planned deployment is near a facility—such as a race track, golf course, or stadium—at which portable C-band operations are likely to occur.

Importantly, portable C-band terminals used for occasional and one-time operations such as unanticipated news events, do not require receive protection. C-band uplink FSS satellite operations occur in the 6 GHz band, whereas the 3700–4200 MHz band is only used for downlinks. In other words, portable terminals use

3700-4200 MHz only to monitor signals, not transmit them. Thus, even in the unlikely case that interference occurs in the 3700-4200 MHz band, it will not adversely affect the quality of the FSS operator's outgoing signal, which is the more important operation.

P2MP presents no danger of interference to adjacent-band radio altimeter operations.

Radio altimeters operate in a portion of the adjacent 4200–4400 MHz band, but are concentrated within 4250–4350 MHz, creating a built-in 50 MHz guard band with respect to the adjoining C-band spectrum. P2MP systems, moreover, are engineered to serve customers at or near ground level, and can easily be designed to reduce any stray radiation in the upward direction. P2MP systems in the vicinity of airports can be engineered to avoid pointing at the airport or aircraft approach paths. Demonstrating the absence of any real-world interference concern, at the upper adjacent end of the band above 4400 MHz, there are more than 800 existing Federal point-to-point systems that apparently coexist with radio altimeters today, with no suggestion of a problem.[42]

V. CONCLUSION

The Commission should enable P2MP shared use of the portion of C-band that is not able to be cleared for flexible use at this time. Shared use of C-band FSS frequencies with P2MP broadband services would promote the nation's leadership in the development of 5G applications including fixed wireless, as well as spectrum

[42] *See* NTIA, *4400-4500 MHz*, Dec. 1, 2015, https://www.ntia.doc.gov/files/ntia/publications/compendium/4400.00-4500.00_01DEC15.pdf.

sharing technologies. As corroborated by actual P2MP/FSS shared use of the extended C-band, the *Reed Study* has demonstrated that oversized exclusion zones of 150 km radius around FSS earth stations are unnecessary, and the Commission should reduce these geographic exclusion zones to 10 km or less. Furthermore, enabling FSS/P2MP sharing would require only modest changes to the Commission's Part 101 rules. By taking these steps, more than 80 million Americans, many in rural, small town, tribal, and other underserved areas, could reap the benefits of gigabit-class broadband services.

Respectfully submitted,

Megan Anne Stull
Counsel

Andrew W. Clegg
Spectrum Engineering Lead
Google LLC

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